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Assessing the Vulnerability of Monterey Bay Area Seniors to COVID-19

Ethan A. Quaranta
California State University, Monterey Bay

Gerhard L. Gross
California State University, Monterey Bay

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PROBLEM DESCRIPTION

Our project focused on how vulnerable seniors are in the Monterey Bay Area Tri-County region from coronavirus. The 2019-2020 COVID-19 pandemic has resulted in major socio-economic upheavals, caused staggering death tolls, and radically changed the lives of millions as countries worldwide have instituted quarantine and shelter-in-place policies. As local and state authorities in California come together to address and mitigate the spread of COVID-19, perhaps the greatest challenges they face are how to assess who is most vulnerable and how to best distribute life-saving resources. Geographical Information Systems (GIS), a computerized map-making system, is rapidly becoming a critical tool for analyzing the spatial distribution of risk and resources.

In their essay, Maged Boulos and Estella Geraghty explain why integrated GIS technology is vital for making informed decisions in response to COVID-19. They start by assessing how the risk of contracting COVID-19 is greater than previous respiratory illnesses, noting that it took COVID-19 just 48 days to infect the same amount of individuals that the Severe Acute Respiratory Syndrome (SARS) virus did in 4 months and the Middle East Respiratory Syndrome (MERS) virus did in around 2.5 years. They list several ways that GIS can help keep up with the rapidly changing data environment, citing online real-time mapping of disease cases, social media reactions to disease spread, predictive risk mapping using population travel data, tracing and mapping super-spreader trajectories, and mapping contacts across space and time (Boulos & Geraghty, 2020). While Boulos' and Geraghtys' analysis provides a comprehensive, historically-backed argument in favor of using GIS to monitor the spread COVID-19 in real-time, assess and inform the public of risks and resources available, and help mitigate the increasing load placed on hospitals worldwide by efficiently implementing quarantine procedures, it leaves out the effect of socially-constructed factors on the ability of individuals to access optimal healthcare, a decision that could save many lives.

In our project, we aim to expand on Boulos' and Geraghtys' argument by exploring how social and economic inequalities make it harder for some members of society, namely elders, to access lifesaving treatment than others. According to Vox

Ethan Quaranta is a full-time student at CSU Monterey Bay majoring in Environmental Studies (B.A.) along with double minoring in Environmental Health Policy and Pre-Law. He is set to graduate in Spring of 2022 and seeks to pursue a Master in Public Policy.

Gerhard Gross is a Social and Behavioral Sciences major with a Geographical Information Systems (GIS) concentration. He plans to graduate in Fall 2021. Gerhard is a licensed pilot who aspires to a career in GIS, drones, or the National Park Service.

reporter Umair Irfan, seniors are the most susceptible to COVID-19 because, first of all, "their immune systems are not as strong and are more prone to overreacting to the virus, thus harming their own cells. (Irfan, 2020)" Secondly, Irfan notes that "older people have a higher prevalence of chronic disease, (2020)" putting them at more risk of having complications associated with the disease. The actual death rate among seniors over 70, according to Kathleen Doheny, "is 4.28% compared to an overall death rate of just 1.28%. (Doheny, 2020)" Institutionalized seniors are most at risk; according to NY Times reporter Karen Yourish, "One-third of all U.S. coronavirus deaths are nursing home residents or workers. (Yourish, 2020)" While the Monterey Bay Area Tri-County region has had a relatively lower caseload than other parts of California and the U.S., the effects of COVID-19 are still felt strongly throughout each county. According to Monterey County Weekly Reporter Pam Marino, "As of April 20, Monterey County has up to 4 deaths and 26 hospitalized. (Marino, 2020)" Santa Cruz county, according to KSBW8 news, "has the second highest number of cases (131) and 2 deaths, while San Benito county has the lowest caseload (51) and 2 deaths. (Copitch, 2020)" As the pandemic progresses and more people get infected, critical dilemmas of how to efficiently allocate resources to those most in need will arise. We argue that seniors aged 65 and over, particularly those have no health insurance, should be considered a priority for Bay Area emergency responders. In our analysis of COVID-19 in the Bay Area Tri-County Region, given standard response times for ambulances from local hospitals, we aim to find out how many people aged 65+ are the most vulnerable to COVID-19 and the furthest away from help.

DATA MODEL

Our primary platform was ArcGIS Online (AGOL), a cloud-based platform that allows users to create and share web maps, as well as download and edit them in desktop GIS software. We also used desktop GIS software to cut down map layers, data files that depict spatial information, to our study area.

COVID-19 Cases in the U.S.

Our first step was to acquire an up-to-date layer on coronavirus cases. We used ArcGIS Online Living Atlas, ESRI's continually updated public database of a variety of spatial information, to find the most up-to-date information for the U.S. and Canada using data from the World Health Organization (WHO), U.S. Center for Disease Control and Prevention (CDC) (along with international CDC organizations as well), Worldometers.info, state and national government health departments, and local media reports. We used the number of active cases as our primary method of measurement.

California Counties

To narrow our study area to the tri-county region, we added a California counties layer to our map, and set it to display each county name. We cut down the layer to show just the tri-county region using desktop GIS software. The resulting layer was then imported as a layer to ArcGIS Online . We then used ArcGIS Online to combine the tri-county layer with COVID-19 layer in order to show the number of COVID-19 cases by each county.

Tri-County Hospitals

To obtain spatial data on tri-county hospitals, we used a manual method that consisted of entering the addresses of each hospital from covid-19.direct into Google Sheets, then uploading the sheet ArcGis Online. This allowed the GIS software to automatically determine the exact location of each hospital. Our primary attributes, data that describes geographic features, list the

name, address, county of origin, and the total number of available beds for each hospital.

Nursing Homes

We used the same method as described above for locating the tri-county nursing homes, except that we got the data from caring.com. Each is represented as a point on the map with attributes for name, address, and county of origin.

Census Data

We acquired California Census information from Living Atlas and intersected the layer to the tri-county layer to narrow the data to our area of interest. To find specific information on seniors aged 65 and over, we added the annually-updated American Community Survey (ACS) Context for Senior Well-being from Living Atlas to our map. This data layer translates demographic information about the U.S. senior population to spatial representation on a map. We then used ArcMap to intersect it with the tri-county census tract layer. Our primary attributes for the ACS layer include a total number of seniors over age 65, and seniors over age 65 who have no health insurance.

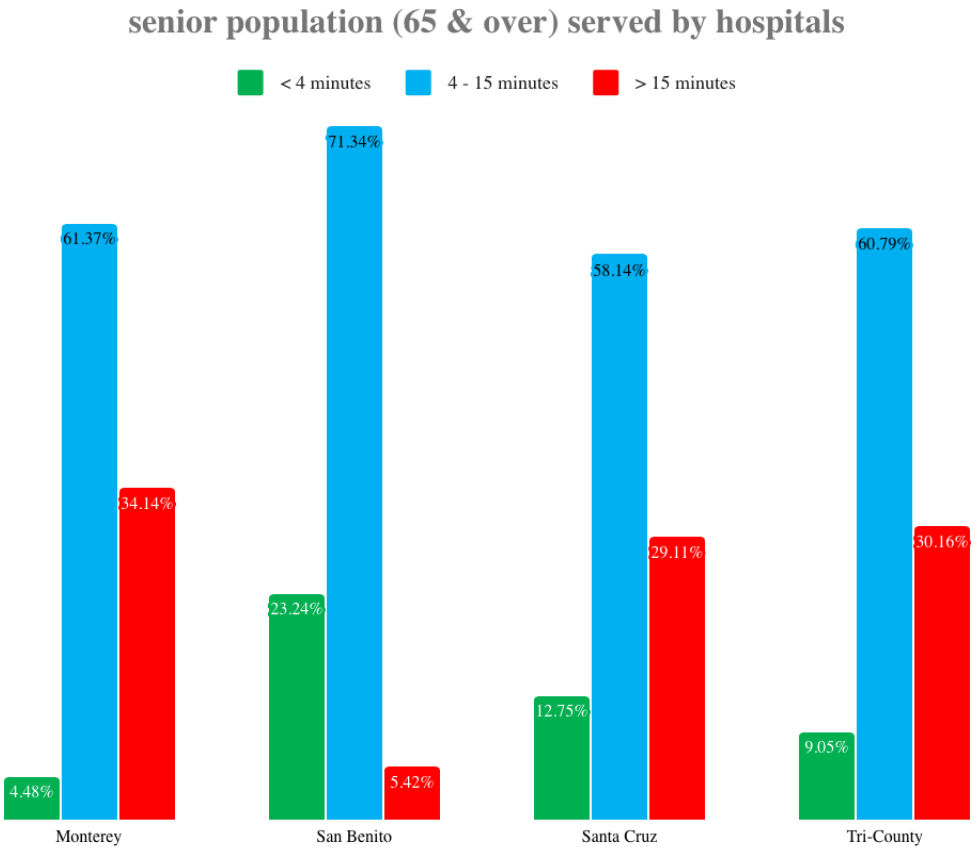

Fig. 1: Seniors > 65 relative to service areas

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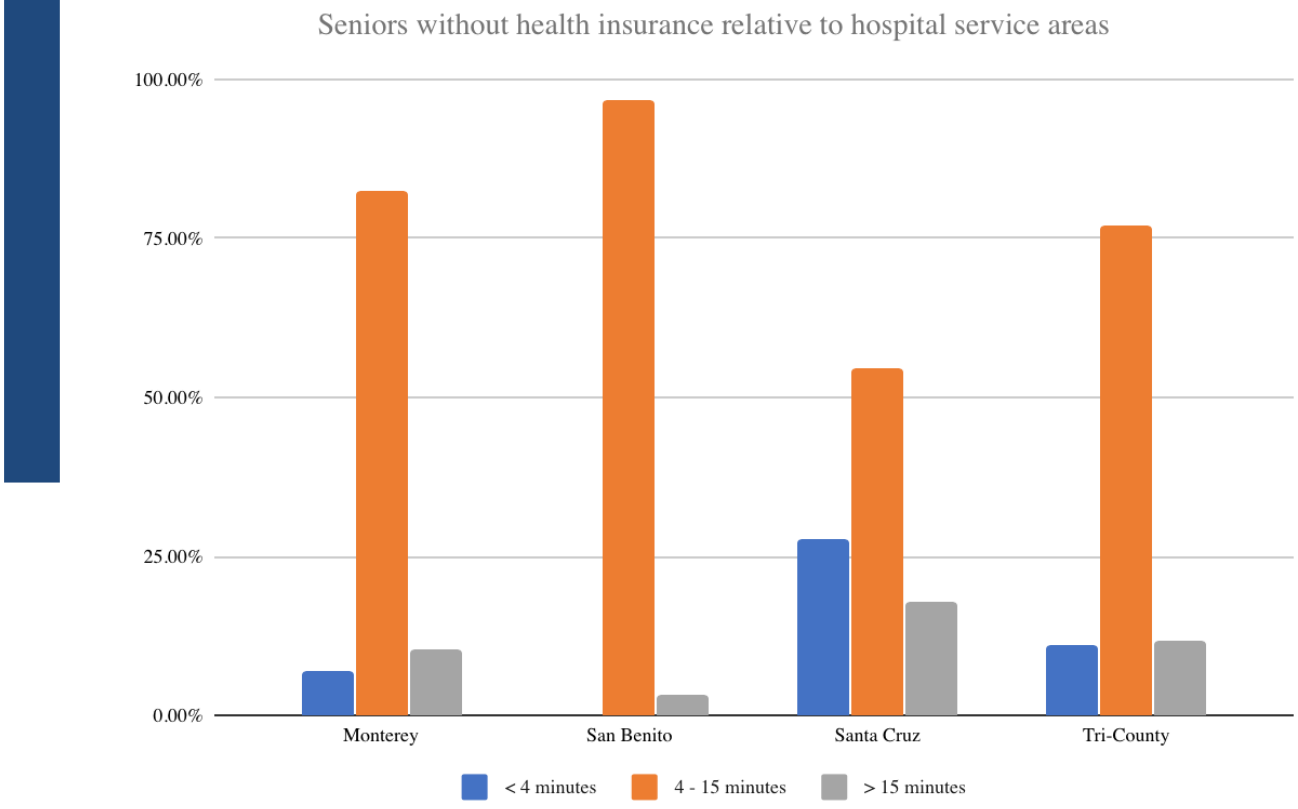

Fig. 2: Seniors > 65 with no health insurance relative to service areas

ANALYSIS AND SYSTEM DOCUMENTATION

We began by creating ambulance service areas for our hospitals. Using Google, we found that the acceptable response times for ambulance crews ranges from 4-15 minutes. Using this information, we performed a Drive-Time Analysis in ArcGIS Online to create 4-15 min. service areas for each hospital on our map. These service areas denote light purple and dark purple areas that can be reached in 4 minutes and 15 minutes, respectively. We then deter-mined which nursing homes were within or outside the service areas. We considered those within a 4 minute drive to the hospital to be adequately served, those within a 15-minute drive to be borderline, and those completely outside of the service areas to be underserved (Fig. 3). However, we knew that limiting our analysis to nursing homes would fail to account for the countless seniors who are not in nursing homes and those without health insurance. To determine the true scope of seniors who may be harder to reach by ambulance crews, we selected each service area and found the total number of seniors for each service area broken down by each county as well as the region as a whole. Using this method, we were able to calculate the number and percentages of seniors aged 65 and over within different ranges from hos-pitals as well as for those who do not have health care coverage. We have presented these figures below in graph format (Fig. 1, 2).

The data we gathered reveals a concerning proportion of seniors who are well outside the recommended ambulance

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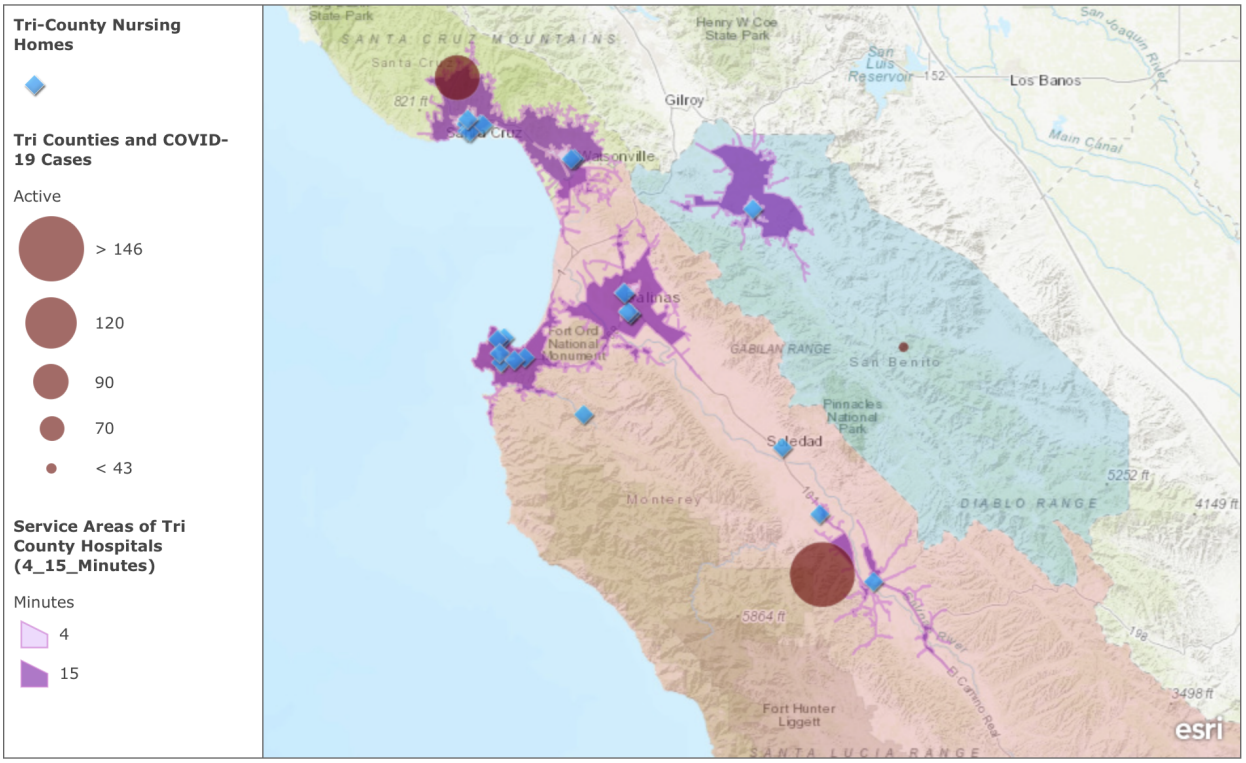

Fig. 3: Tri-county nursing homes vs. hospital service areas vs. COVID-19 cases, May 2020

response times. We began by analyzing how many of the 26 nursing homes we had mapped were outside the service areas. In Santa Cruz, we found that all were within the service boundaries. Out of those, 2 were within the 4-minute response time, and 6 were within the 15-minute response time. San Benito has only one nursing home, which is also part of its only hospital, negating any further analysis. Out of the nursing homes in Monterey, 14 were within service boundaries and 3 were completely outside of service boundaries. Out of the 11 institutions within the service areas, 7 were within 4-minute response time, and 4 are within 15-minute response time. For COVID-19 cases by county, we found that as of May 1st, 2020, Santa Cruz had 109 active cases, Monterey had 146, and San Benito had 43 active cases (Fig. 3).

However, our analysis of nursing homes provided only a fraction of the story. As referenced in the table above, we found that 30.16% of all seniors aged 65 and over were completely outside of the hospital service areas in the entire Tri-County Region. Additionally, 9.05% are within the four minute or less service area and 60.79% are in the four to fifteen minute service areas of Tri-County Hospitals (Fig. 1). Out of the seniors in the Tri-County region who had no health insurance, about 12% were outside the service zones, while 77% were within the 4-15 minute zone, and 11% were within the 4-minute zone. Breaking down these figures by county, we found that 34% of seniors over 65 in Monterey County were outside of the service zones while 11% of Monterey seniors without health insurance were outside of the service zones. Santa Cruz had 29% of its seniors over 65 and 18% of seniors without health insurance outside of the service zones. San Benito had the least proportion of seniors outside of the service zones (5% of the total number of seniors over 65 and 3% of those without health insurance) (Fig. 4). Out of

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those who were within the service zones, 9% of all seniors 65 and over in the Tri-County region were within a 4-minute drive to the hospital, while 61% were between 4 and 15 minutes away. In Monterey County, 4% were within the 4-minute zone and 61% were within the 4-15-minute zone. Santa Cruz had 13% within 4 minutes, and 58% between 4-15 minutes. Finally, 23% of San Benito seniors were within the 4-minute zone while 71% were within the 4-15 minute zone.

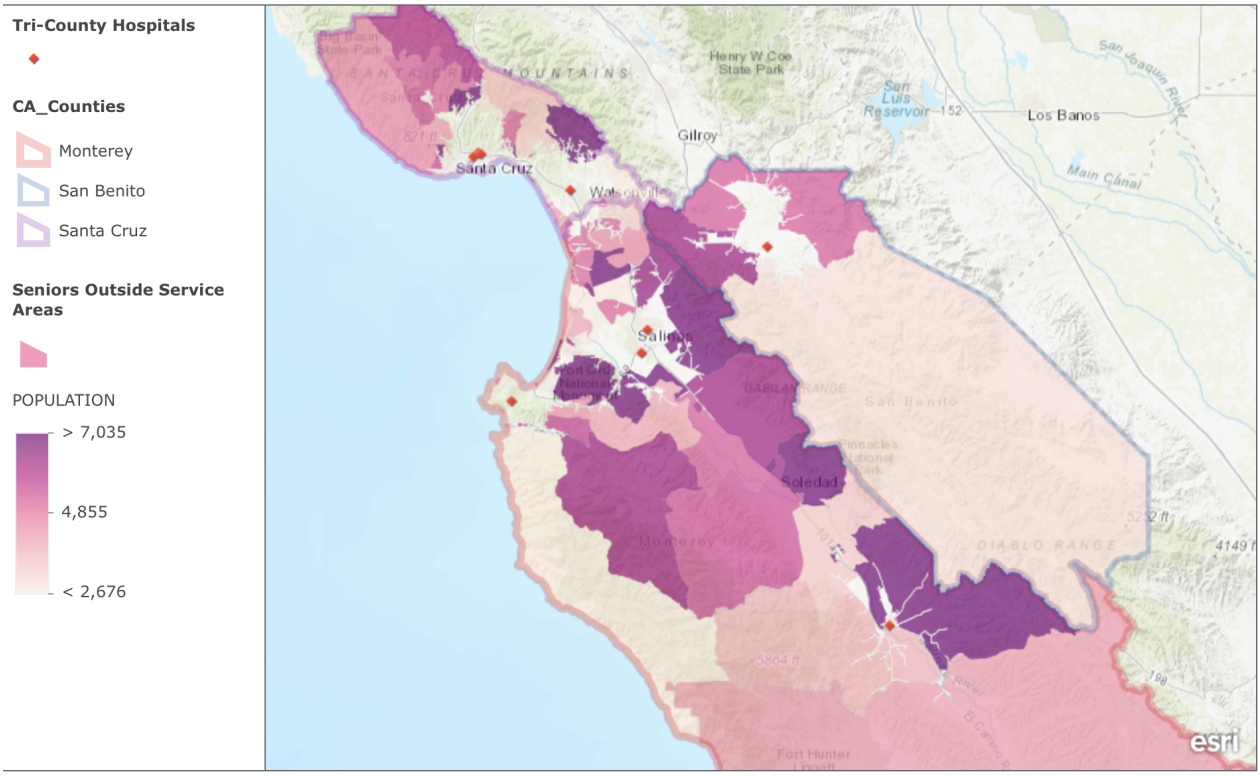

Fig. 4: Seniors outside of service zones

RESULTS & CONCLUSION

Following our analysis, it is clear that Monterey County is the most at risk for seniors since it had the highest overall proportion of seniors and number of nursing homes that were completely outside the hospital service zones, as well as the most COVID-19 cases. Based on this, we recommend additional resources/temporary hospitals to be allocated to Monterey County. However, of the nursing homes in Monterey County that were within the service areas, the majority were within a quick 4-minute drive to the hospital. On the contrary, the majority of nursing homes in Santa Cruz County within the hospital service zones were within the 15-minute buffer, which could pose a potential accessibility problem for Santa Cruz seniors in the event of an infection surge (Fig. 3). Moreover, the highest proportion of seniors without health insurance who were outside of the hospital service zones were within Santa Cruz County (Fig. 2). Given the notoriously high cost of living in Santa Cruz, it is not surprising that more Santa Cruz County seniors without health insurance are further away from the hospital than those in other counties. It also raises questions of the

influence of socioeconomic inequities on access to healthcare in the county. A few hotspots we identified that contained the most seniors outside of the service areas were located in North-Central Santa Cruz County outside Scotts Valley and Felton, North-Western and North-Eastern San Benito County, and Central/Eastern Monterey-County (Fig. 4). Additionally, we noted that out of all the seniors who were within the hospital service zones, only a small proportion could reach a hospital in 4 minutes, while a significantly higher percentage are located 15 minutes away (Fig. 1, 2, and 5). Given the time-critical nature of COVID-19 related medical emergencies, every minute counts, making those over 4 minutes away from the hospital more at risk of succumbing before adequate treatment can be provided. Based on this information, we can conclude that most of the tri-county region is underprepared to serve many of its most vulnerable members of society. Health authorities must be strategic about the placement of resources so that they have adequate access to life-saving treatment.

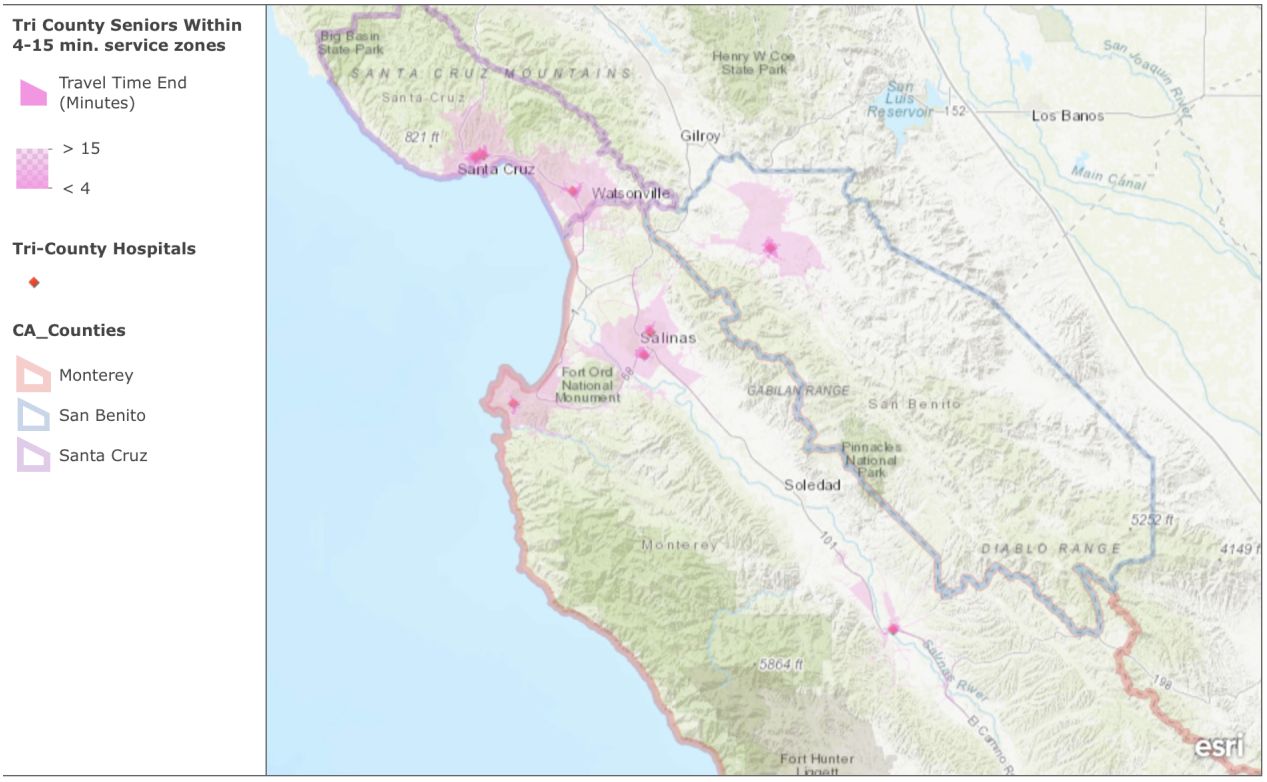

Fig. 5: Seniors inside service zones

STRENGTHS AND WEAKNESSES

One strength of our project is that we were able to seamlessly utilize desktop GIS software to assist with data customization on the cloud-based ArcGIS Online platform as needed by cutting down our layers into more manageable chunks. Through these functions we were able to set up the data in a format that would narrow our study area which allowed us to easily navigate and extract relevant data . Another strength of our project is that we were able to obtain most of our data

via ESRI's Living Atlas, which made data management a little bit easier. Another strength of our project which led to increased productivity and efficiency was exercising good teamwork.

We identified several shortcomings and areas for improvement that we could have implemented with more time. The first thing we could have done was to learn how to use ESRI's Community Analyst, a demographic analysis tool that compliments GIS software, to generate more comprehensive reports. Another direction we would have considered, given we had more time, would be to compare available hospital beds of each hospital to the number of COVID-19 cases and number of seniors within the hospital service areas to find out which hospitals would be the first to become overloaded. One area of interest that we would like to investigate if we did this project again would be to try to determine the most efficient routes to testing facilities in order to recommend possible areas in the region that need improved access to testing. Finally, one fix that would have saved us some time and allowed us to better collaborate would be to figure out how to share our map in ArcGIS Online so that we could simultaneously edit and save it as is possible in other cloud-based services like Google Drive.

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